FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602122N
PROGRAM ELEMENT TITLE: Aircraft Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Aircraft Technology	30,247	20,545	21,057	21,675	22,031	22,067	21,835	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program develops technology for naval aviation, with emphasis on the demands imposed by aircraft carrier flight operations and Marine Corps amphibious and field operations relating to the Joint Mission Areas of Strike and Littoral Warfare. This program exploits the emerging technologies of: (a) structures and flight controls to reduce the total life-cycle-cost and extend the operational life of legacy air vehicles; (b) reduced observables, (c) aerodynamic designs of Navy-unique aircraft components; (d) advanced gas turbine engine component designs and power systems for extended range/endurance; and (e) predicting safer, more reliable at-sea operating envelopes. The program provides mission area analysis and concept definition required for the Applied Research phase of air vehicle programs.

(U) Aircraft Technology develops manned and unmanned airborne platform technologies for future joint warfighting capabilities to promptly engage regional forces in decisive combat on a global basis and to employ a range of capabilities more suitable to actions at the lower end of the full range of military operations, which allow achievement of military objectives with minimum casualties and collateral damage. This element adheres to Defense Science and Technology (S&T) Reliance Agreements and supports the Department of Defense Science and Technology Strategy, which coordinates and minimizes duplication of aircraft technology efforts. The individual Navy aircraft technology applied research efforts are selected to fill Naval Aviation needs that are not being met by the United States Air Force, Army, National Aeronautics and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA) and industry programs.

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(U) Aircraft Technology addresses the Air Platforms Defense Technology Area Plan (DTAP), which develops goals and payoffs from both the operational user's and system & technology developer's perspective. At the Project Reliance Fixed Wing Vehicle taxonomy level, goals include Aerodynamics, Flight Control, Subsystems, Structures and Integration technologies. The following reflects the Joint Subarea Level goals for fighter/attack aircraft for the year 2003 (baseline F-22 & F-18E/F),: 0% increase in production cost/Air Vehicle Weight; 0% increase in development costs/Air Vehicle Weight; 20% reduction in support costs per flight hour/Air Vehicle Weight; 10% increase in lift-to-drag; 8% reduction in Air Vehicle weight fraction; 20% increase in controllable angle-of-attack envelope. Holding constant the three cost goals (0%) represents a break in the paradigm currently faced with high-performance tactical aircraft of ever increasing cost per pound of airframe. There is also an increasing emphasis on developing technology which addresses the cost-of-ownership of legacy airframes.

(U) Based on the Secretary of Defense’s Blue Ribbon panel’s recommendation, after studying F/A-18E/F transonic wing drop, a joint program to develop an understanding of the fundamental flow phenomenon and develop technology to reduce/control abrupt asymmetric wing stall of fighter aircraft will be funded under this and other program elements. This effort will fund the development of a basic understanding of the transonic abrupt wing stall problem, figures of merit and guidelines to prevent abrupt transonic wing stall and improve maneuverability. This effort is planned as a joint effort with Navy, NASA, Air Force (AF) and industry.

(U) Aircraft Technology has a limited investment in Navy unique or critical technology for Rotary Wing Vehicles and seabased vertical flight operations. These efforts are coordinated with the Army’s Rotary Wing Vehicle (RWV) science and technology subarea under the DTAP.

(U) Other Joint Subarea Level quantified goals are addressed under the Air Platforms DTAP: Aeropropulsion (by year 2003; baseline engine YF-119 for fighter/attack aircraft, T700/T406 for patrol/transport/rotary wing aircraft, and F107 for missiles/Unmanned Air Vehicles (UAVs)): 100% increase in thrust-to-weight, 35% reduction in acquisition & maintenance cost, 40% reduction in fuel consumption, and 120% increase in specific thrust; and by year 2010, 150% increase in thrust-to-weight and 50% reduction in development costs. Aircraft Power (by year 2000; baseline F-18E/F & F-22): Eliminate hydraulic system; 10 times increase in reliability.

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(U) Other DTAPs addressed by Aircraft Technology: Sensors, Electronics & Electronic Warfare; Integrated Platform Electronics (by year 2005): Reduce size, weight and cooling requirements by 50% for Fixed Wing Vehicle (FWV) and 40% for RWV; and 50% reduction in cost for multifunction Radio Frequency (RF) avionics.

(U) Human Systems (by year 2001; baseline F-18E/F & F-22): Achieve crew safe escape to 700 KEAS; 50% reduction in aircrew workload attributable to effective crew station integration, enabling single-seat, air-to-ground precision weapons delivery at night and in adverse weather; Improve mission effectiveness (50% reduction in target acquisition time); Improve lethality (3:1 increase in targets killed per pass); Increase survivability (2:1 improvement in kill ratio); Enhanced situational awareness (75% reduction of head-in cockpit time).

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems. Aircraft Technology addresses the Materials/Processes DTAP by developing Condition Based Maintenance (CBM) enabling technologies for aviation, with the emphasis on increased affordability, safety and operational flexibility. Specific goals of the program include an 80% reduction in aircraft mechanical mishaps, 35% reduction in the required inventory of spare parts and a 30% reduction in overall aircraft maintenance costs. This effort is part of a vertically integrated, multi-disciplinary program in condition based maintenance that leverages from Program Elements 0602233N, 0602234N and 0601153N.

(U) Due to the sheer volume of efforts included in this Program Element (PE), the programs described in the Accomplishment/Plans sections are representative selections of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

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- (U) PROPULSION & POWER:
  (U) Initiated:
  - (U) Development of Power Electronic Building Blocks (PEBBs) for Naval aircraft applications.
  - (U) Testing of Carbon/Carbon lightweight heat exchanger technology for Naval Aircraft application.

  (U) Continued:
  - (U) Development of Joint Technology Demonstrator Engine (JTDE) Fighter/Attack Phase III fan for 5% increased efficiency, 50% increase in stage loading and improved distortion and Foreign Object Damage (FOD) tolerance. Effort will provide specific thrust allowing F/A-18 growth.
  - (U) Rig testing of advanced high temperature turbine sealing concepts. The reduced leakage will result in a fuel consumption reduction of 2 percent and increased range for both subsonic support and fighter/attack applications.
  - (U) Design and fabrication of a ceramic matrix composite (CMC) turbine vane to increase temperature capability by 400 degrees or improve durability, over metallic designs.
  - (U) Design and sector rig testing of an Advanced Gas Generator/JTDE Phase III affordable combustor. It will provide reduced weight and cost for Fighter/Attack and Vertical/Short Take-Off and Landing (V/STOL) applications.

  (U) Completed:
  - (U) Rig demonstration of a fuel flow metering system that will provide more precise main fuel system delivery to the engine while reducing weight, production and maintenance costs.
  - (U) Demonstration of Phase II Fighter/Attack category engine fan, turbine and afterburner components in a full engine configuration to increase thrust-to-weight by 50% and reduce acquisition and maintenance cost by 20%.
  - (U) Rig demonstration of a radial turbine blade damping concept which reduces stresses and increases turbine life by 50% and reduces weight by 20%.
  - (U) Demonstration of a turbine blade leading edge cooling concept that will be incorporated into an engine design to improve durability.

- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):

(U) Continued:
- (U) Demonstration of an intelligent crewstation concept to include an onboard computer to continuously assess the conditions of the pilot and the aircraft relative to the escape envelope, and a measurement and control system to unobtrusively monitor aircrew physiological functions.
- (U) Development of a smart aircrew interface required to support the effective cockpit sub-system integration of the intelligent crewstation.
- (U) Investigation of an Advanced Multi-Mode Helmet Vision System to effectively merge real-time sensor information as well as synthetically generated environment imagery.
- (U) Development of advanced analog-to-digital Advanced Common Electronic Modules (ACEMs) technology to enhance air vehicle capability by performing multiple avionics functions. This work transitioned to the 0603217N P.E. at the end of FY 99.

(U) Completed:
- (U) Demonstration of a smart cockpit controller to effectively manage the functions of the life support, escape and control/display subsystems to achieve a 50% reduction in aircrew workload and 50% improvement in mission performance (i.e. target acquisition time/survivability/situational awareness). Transitioned smart cockpit controller software to support simulation and flight test efforts under Navy's Active Network Guidance in Emergency Logic (ANGEL) program.
- (U) Demonstration of component building block technology for a (non-moving parts) 3-Dimensional volumetric display.

- (U) NAVAL AIR VEHICLE TECHNOLOGY:
  (U) Initiated:
  (U) Detailed study of the existing F/A-18E/F wind tunnel, flight test and Computational Fluid dynamic (CFD) database to establish an understanding of the abrupt wing stall phenomena. Design and manufacture of the first set of highly instrumented wings for the 8% F/A-18E wind tunnel model. Develop figures of merit and a preliminary flow physics model for the abrupt wing stall phenomena using flight test, wind tunnel test and CFD data.

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– (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provide automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.

- (U) Development and simulation demonstration of an adaptive fault-tolerant flight control system for ship-board auto-land of unconventional aircraft.
- (U) Definition of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery. The requirements will reduce FCS development time/costs and lead to a reduction in shipboard accidents.
- (U) Evaluation of the capability of the Vectored Thrust Ducted Propeller (VTDP) Compound Helicopter technology to: (i) perform/enhance Airborne Mine Counter-Measures (AMCM), (ii) improve multi-mission rotorcraft speed, range, survivability and reduce life cycle cost, (iii) evaluate and mitigate the impact of increased weight empty and hover power required, and (iv) utilize the H-60 as the technology demonstration platform. This effort will transition to Program Element 0603792N in FY 2000.

(U) Continued:

- (U) Technical support to Defense Advanced Research Projects Agency (DARPA) and Boeing in the design, fabrication and testing of an Unmanned Air Vehicle (UAV) to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
- (U) Development of novel concepts to control or limit the suckdown, thermal and acoustical environment penalty associated with the VSTOL from a surface combatant. Developed more accurate and efficient modeling and prediction capability to evaluate VSTOL aerodynamic characteristics of manned aircraft and Uninhabited Combat Air Vehicle (UCAVs). Updated current VSTOL design handbook for modern configurations.
- (U) Development of a corrosion-fatigue interaction analysis to support the aging aircraft service life extension requirements. It provides prediction capabilities to optimize maintenance inspection and repair thereby reducing the corresponding Operation and Maintenance (O&M) cost by at least 10%.
- (U) Development of a durability-based design criteria for bonded composite patching of metal structures. The product allows a service life extension of aircraft heretofore requiring structural component replacement or by replacement with new platforms.

- (U) Development of structural life enhancement techniques applicable to both new and aging aircraft to support objective of increasing fatigue service life by 25%.
- (U) Development of improved tactical aircraft high-lift system configurations and a validated 3-dimensional optimization/design method for high-lift systems.

(U) Completed:
- (U) Generation of a comprehensive document containing past aircraft configurations, which exhibited similar wing stall characteristics. Flight-tested F/A-18E/F configuration to obtain detailed wing surface pressure distributions to provide a better understanding of the existing flow field. Completed the first highly instrumented high-speed wind test and obtained both static and dynamic wing data. Used Computational Fluid Dynamic (CFD) techniques to develop a preliminary flow physics representation of the abrupt wing stall phenomena.
- (U) Development of guidelines to alleviate empennage buffet during high alpha maneuvering of fighter/attack aircraft. Completed development of coupled unsteady aerodynamics and structures interaction methods.
- (U) Joint Service demonstration of an Advanced Molecular Optical Air Data acquisition sensor.
- (U) Demonstration of Nonlinear Adaptive Control Algorithms on both damaged and undamaged aircraft simulations.
- (U) Demonstration of real-time battle and mid-air collision damage identification and estimation algorithms on a high fidelity nonlinear six degree of freedom high performance aircraft simulation.
- (U) Flight test of an adaptive neural network flight control system on an aircraft with simulated failure cases.

- (U) OXIDE PURPLE:
  - (U) Classified.

2. (U) FY 2000 PLAN:

- (U) PROPULSION & POWER:
  (U) Initiate:

- (U) Design of advanced prognostic, diagnostic and health monitoring control system to reduce maintenance costs for Fighter/Attack and UCAV systems.
- (U) Design of an advanced high durability, corrosion resistant bearing system for reduced maintenance cost and increased reliability.
- (U) Development of low-cost, integrally bladed rotor for compressors using advanced low cost manufacturing process, relevant to fighter/attack and rotary-wing aircraft applications.

(U) Continue:
- (U) Development of PEBBs for Naval aircraft applications in support of the More Electric Aircraft (MEA) initiative.
- (U) Design and fabrication of JTDE Phase III Fighter/Attack Fan for increased efficiency stage loading and distortion tolerance.
- (U) Development of improvements in turbine system components to increase durability by 50%.
- (U) Rig testing of a CMC turbine vane to increase temperature capability by 400 degrees over metallic designs.

(U) Complete:
- (U) Rig testing of advanced high temperature turbine sealing concepts. The reduced leakage will result in a fuel consumption reduction of 2% and reduced costs of 50% for increased range for both subsonic support and fighter/attack applications.
- (U) Sector rig test of an Advanced Gas Generator/JTDE Phase III affordable combustor. It will provide reduced weight and cost for Fighter/Attack and V/STOL applications.

- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):
(U) Continue:
- (U) Integration of high definition display prototype into flight worthy multi-mode helmet vision system configuration.

(U) Complete:
- (U) Effort that focuses on enhanced affordability and safety by advancing state-of-the-art maintenance technologies, and develops the capability for critical machinery self-diagnosis, in order to transition from a time-based to a condition-based maintenance philosophy.
- (U) Building block helmet mounted display technology for transition to Fleet via the Joint Helmet Mounted Cueing System (JHMCS); basic magnetic head tracker, common helmet/vehicle interface, and visor optics.
- (U) Development and demonstration of algorithms that generate tactically useful, real-time cockpit imagery fused from off-board and on-board information sources. These will automatically choose from sets of images only those which correspond to a specific target and present it on a helmet-mounted or other display.

(U) NAVAL AIR VEHICLE TECHNOLOGY:

(U) Initiate:
- (U) Prediction of dynamic load effects on structural fatigue life for fixed and rotary-wing aircraft.
- (U) Development and real-time hardware demonstration of flight systems damage and failure diagnostics/prognostics approaches for reconfigurable flight control, condition-based maintenance, and improved pilot situational awareness to improve safety, survivability, and affordability.

(U) Continue:
- (U) Development of an improved Abrupt Wing Stall (AWS) flow physics model and aircraft design guidelines using newly acquired wind tunnel, flight test and CFD data. Development of a high-speed ground based dynamic test capability to diagnose the AWS phenomena. Initiate a flight test program in cooperation with NASA. Design and manufacture the second highly instrumented wind tunnel test model.

- (U) Technical support to DARPA and Boeing in the design, fabrication and flight testing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
- (U) Development of a corrosion-fatigue interaction analysis with emphasis on random scatter of material properties.
- (U) Development of a reliability analysis capability for bonded composite patching of cracked metallic structure.

- (U) Development of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery.
- (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provides automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.
- (U) Development and simulation demonstration of an adaptive fault-tolerant flight control system for shipboard auto-land of unconventional aircraft.

• (U) OXIDE PURPLE:
- (U) Classified.

3. (U) FY 2001 PLAN:

• (U) PROPULSION AND POWER:
(U) Initiate:
- (U) Design of a low cost, high temperature turbine system relevant to high-speed missile and UCAV systems.
- (U) Design of an advanced lightweight, V/STOL-relevant fan system compatible with low cost manufacturing processes.
- (U) Rig test of a low volume combustor that will reduce frontal area of missiles to reduce drag and increase range.

(U) Continue:
- (U) Fabrication of full annular rig of a CMC combustor for subsonic, UCAV and rotary-wing aircraft applications to increase cycle temperature.
- (U) Testing of advanced prognostic, diagnostic and health monitoring control system to reduce maintenance costs for Fighter/Attack and UCAV systems.

(U) Complete:
- (U) Rig testing of a full-size Advanced Gas Generator/JTDE affordable combustor. It will provide reduced weight and cost for Fighter/Attack and VSTOL applications.
- (U) Testing of JTDE Phase III Fighter/Attack Fan for increased efficiency stage loading and Foreign Objective Damage (FOD) and distortion tolerance.
- (U) Testing of an advanced high-durability, corrosion-resistant bearing system for reduced maintenance cost and increased reliability.

- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):
  (U) Continue:
  - (U) Overall multi-mode visually-coupled display system technology integration enhancement between visor optics, 3-D audio, precision head tracking and selected threat protection technology.

- (U) NAVAL AIR VEHICLE TECHNOLOGY:
  (U) Initiate:
  - (U) Development of technology for integrated multi-disciplinary optimization of manned aircraft and UAVs.
  - (U) Development of bonded composite patch repair of corrosion damage to supplement the costly practices in current depot maintenance.

  (U) Continue:
  - (U) Development of prediction of corrosion-assisted fatigue degradation within a scatter factor of four to develop engineering guidelines for maintenance practices.
  - (U) Development of analysis of dynamic load effect on fatigue life.
  - (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provides automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.

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(U) Complete:
- (U) AWS flow model development, demonstration of aircraft design guidelines and figures of merit on a present/future fighter/attack configuration.
- (U) Flight testing with DARPA and Boeing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
- (U) Definition of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery. The requirements will reduce FCS development time/ costs and lead to a reduction in shipboard accidents.
- (U) Preliminary Design Review of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.
- (U) Preliminary Design Review of fault-tolerant adaptive control laws for ship-board auto-land of unconventional vehicles.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
FY 2000 President's Budget:	28,367	20,660	22,372
Appropriated Value	-	20,660	-
Adjustments from FY 2000 PRESBUDG:			
SBIR/STTR Transfer	-407	0	0
Inflation Rate Adjustment	-132		
Actual Update Adjustments	2,419	0	0
Program Adjustment	0	0	-1,185
Congressional Rescissions	0	-115	0
Various Rate Adjustments	0	0	-141
Mil/Civ Pay Rates	0	0	11
FY 2001 PRESBUDG Submission	30,247	20,545	21,057

(U) CHANGE SUMMARY EXPLANATION:

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(U) Schedule: Not applicable.
(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not Applicable.

(U) RELATED RDT&E: This program adheres to Defense S&T Reliance Agreements on Air Platforms (Fixed Wing, Rotary Wing, Integrated High Performance Turbine Engine Technology (IHPTET), and Aircraft Power), Sensors, Electronics & Electronic Warfare (Integrated Platform Electronics), Human Systems, and Materials/Processes.

(U) Work in this Program Element (PE) is related to and fully coordinated with efforts in the following PEs:

- PE 0601101F (Geophysics)
- PE 0601102F (Materials)
- PE 0601153N (Defense Research Sciences)
- PE 0602201F (Aerospace Flight Dynamics)
- PE 0602202F (Human Systems Technology)
- PE 0602203F (Aerospace Propulsion)
- PE 0602204F (Aerospace Avionics)
- PE 0602233N (Human Systems Technology)
- PE 0602234N (Materials, Electronic and Computer Technology)
- PE 0602708E (Cockpit Autonomous Landing)
- PE 0603003A (Rotary Wing Aircraft Technology)
- PE 0603106F (Logistics Systems Technology)
- PE 0603112F (Advanced Materials)
- PE 0603202F (Aerospace Propulsion Subsystems Integration)
- PE 0603205F (Flight Vehicle Technology)
- PE 0603211F (Aerospace Structures)
- PE 0603216F (Aerospace Propulsion and Power Technology)
- PE 0603217N (Air Systems and Weapons Advanced Technology)

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PE 0603231F (Crew Systems and Personnel)
PE 0603238N (Precision Strike & Air Defense Technology)
PE 0603245F (Advanced Flight Technology Integration)
PE 0603706N (Medical, Personnel, and Training Advanced Technology Development)
PE 0603792N (Advanced Technology Transition)

(U) Advanced Technology Transition in accordance with the ongoing Reliance joint planning process and contains no unwarranted duplication of effort among the Military Departments.

D. (U) SCHEDULE PROFILE: Not applicable.